REPORT

Surrey, Coquitlam, Abbotsford, Burnaby & Township of Langley

Cost Impacts of the
TransMountain Expansion on
Lower Mainland Municipalities

This is Exhibit "B" referred to in the
Affidavit of Larry Martin
sworn before me at Surrey
In the Province of British Columbia
this 25 day of May 20 15
[illegible]
A Commissioner for taking Affidavits
for British Columbia

May 2015

Executive Summary

In October 2014, the cities of Surrey, Burnaby, Coquitlam, Abbotsford and the Township of Langley retained Associated Engineering to complete an assessment of additional costs incurred by each municipality to operate, maintain and construct municipal infrastructure impacted by Kinder Morgan's (KM) existing and proposed TransMountain Pipelines (TMP and TMX, respectively). The objective of the work was to:

1. Identify whether or not municipalities will incur additional costs to develop, maintain and construct their own municipal infrastructure as a direct and/or indirect result of the proposed TMX.
2. Quantify the present and estimated future additional costs that each subject municipality would incur as a result of the proposed pipeline operating within the vicinity of existing and future municipal infrastructure.
3. Suggest mitigation opportunities KM could undertake in respect of the proposed TMX to reduce future costs that would otherwise be incurred by the subject municipalities.

The projected additional costs that the subject municipalities will incur as a result of the proposed TMX projected over 50 years exceeds $93,000,000 as set out in Table 1-2.

1 RATIONALE

Municipalities install and maintain infrastructure in their communities to meet the present and future needs of their residents and industries. Kinder Morgan proposes to install its pipeline in municipal roads which are congested with utilities and, as part of municipal annual O&M and long term needs to service residents, municipalities incur higher costs which are not reimbursed by KM. If the pipeline was not in municipal roads, these costs would not be incurred.

Private utilities, such as BC Hydro, Telus and FortisBC, also have infrastructure routed through these municipalities. In what has become a normal routine, municipal staff work with these private operators to avoid impacting each other's property, and in so doing, avoid costly errors. In the case of the Lower Mainland municipalities, all parties have strict permitting, access and engagement requirements.

The results from this exercise do not quantify the initial TMX installation costs to the subject municipalities, but the additional costs incurred by the municipalities once it is in the ground. AE then examines what mitigation options can be implemented by KM to reduce these future costs.

Particularly costly to the municipalities is the potential of paying the entire cost of moving the TMP or TMX to accommodate future municipal infrastructure needs. Kinder Morgan has already identified in the NEB hearing process that the pipeline installation is expected to cost (in the range of) $6,000 per metre. Excavating and relocating this pipe (whether by depth or to another location) could easily double or triple this cost. The alternative would be leaving KM's infrastructure in place and altering the municipalities' usual

construction plans and design standards to work around the KM infrastructure, which would impose a potentially equally large financial burden on the municipalities. The municipalities have 20 year capital works plans which help identify some projects, however, the scope beyond to the 50 year horizon is inherently more vague.

2 OVERALL METHODOLOGY

The TMX concept and alignment is currently under review. To determine the cost impact of the TMX project on the operation, maintenance and construction of municipal infrastructure utilities, Associated Engineering chose to evaluate current practices involved with working around the existing TMP, and develop historical benchmarks for costs. The work plan included:

1. Identifying where municipalities were incurring additional costs due to operation, maintenance and construction of municipal utilities around the existing TMP.
2. Quantifying additional costs incurred by municipalities as a result of the existing TMP being located in close proximity to municipal infrastructure.
3. Projecting the impact of the proposed TMX on the existing municipal infrastructure and quantifying the additional costs associated with operating and maintaining existing municipal infrastructure within the pipeline's vicinity.
4. Projecting and quantifying the additional costs associated with constructing new municipal infrastructure around the proposed TMX.
5. Reviewing potential mitigation practices which would reduce the cost impacts on the municipalities.

3 BACKGROUND REVIEW

Information, documentation and system data were collected from a variety of sources. This included KM's application and supporting reference materials in the NEB hearing process for the TMX, as well as other KM documentation available online regarding policies, practices and regulations in place with other municipalities. We note that KM's application to the NEB provides different standards of construction for the TMX than KM requires for new construction of facilities around the existing line.

4 COST BENCHMARKING

AE then met with staff of each municipality separately. From the subsequent discussions, it was confirmed that the municipalities were, in fact, incurring additional costs in operating, maintaining and constructing municipal infrastructure, due to the presence of the existing TMP.

AE compiled a list of activities and projects outlining examples of additional costs in operations, maintenance and construction of new and existing facilities and infrastructure in the vicinity of the TMP. The result was that the municipalities were being impacted by both direct and indirect costs:

- Direct costs involved a visible, measurable cost including those associated with permitting, risk mitigation, design and construction. These costs were generally associated directly with a single maintenance incident or construction project.
- Indirect costs were generally comprised of administrative and coordination costs due to the overall operation of municipal infrastructure in proximity to the TMP.

Of particular note, municipalities are replacing some assets before the end of their typical useful life as a result of the TMP. This is particularly evident with respect to municipal roads in proximity to the TMP in areas of wet or peaty soils. The municipalities understand that their road infrastructure is vulnerable to settlement in these areas, yet the pipeline settles at different rates causing road safety concerns and increasing the rate of replacement of the municipal infrastructure.

The benchmarking exercise involved compiling the actual additional costs from different example projects supplied by the municipalities into a series of unit cost scenarios. These unit costs scenarios were then applied to develop cost estimates for each of the municipalities.

Additional costs were categorized into three main asset groupings:

- Buried utilities (water, sanitary, storm)
- Road infrastructure
- Overland drainage (ditches and creeks)

5 ANALYSIS

A comprehensive analysis was conducted to quantify where municipal assets and the existing TMP and proposed TMX alignments intersected.

Additional costs were then generated using the unit costs produced during the benchmarking exercise, and applied to the GIS ‘count’ of each impacted municipal asset. Operating and maintenance (“O&M”) costs were derived using O&M records provide by the municipalities. Additional costs involved in replacing an asset were derived by using an industry-standard assumption that all buried assets and ditches would be replaced once every 50 years, and that roads would be completely replaced after an expected useful life of 40 years. These costs were then averaged and annualized.

A similar analysis was then performed for the proposed TMX route using the same assumptions, and the permitting and regulatory needs for horizontal and vertical clearances from the KM pipeline.

6 RESULTS

A summary of additional costs of the impacts of both the existing and proposed pipelines are presented, by municipality, in Table 1-1. Although the additional costs around the TMP tend to be higher than the TMX, there has been over 60 years of development around the TMP. It is therefore reasonable to assume that the cost to the municipalities as a result of the TMX will increase over time as development progresses.

Table 1-1
Summary of Annualized Additional Costs for Existing Infrastructure

Municipality	O&M [1]	Replacement[1]	Subtotal
TMP			
Burnaby	$143,600	$1,078,000	$1,221,600
Coquitlam	$107,300	$1,505,000	$1,612,300
Surrey	$154,200	$1,015,000	$1,169,200
Langley Township	$84,500	$356,000	$440,500
Abbotsford	$87,300	$472,000	$559,300
Totals[2]	$576,900	$4,426,000	$5,002,900
TMX			
Burnaby	$77,900	$156,000	$233,900
Coquitlam	$116,200	$316,000	$432,200
Surrey	$59,800	$260,000	$319,800
Langley Township	$52,000	$204,000	$256,000
Abbotsford	$44,500	$292,000	$336,500
Totals[2]	$350,400	$1,228,000	$1,578,400

Notes
1. Includes Administration and Coordination, Risk Mitigation and Contingency (industry practice is 40% for Class 5 projects)
2. All values in 2014 $.

Table 1-2 is a summary of the expected additional cost impacts expected over the next 50 years by each municipality due to the construction of the proposed TMX.

Table 1-2
Summary of Additional Costs to be incurred by the Municipalities over 50 years

Municipality	TMX	Future Expected Projects	Totals
Burnaby	$11,700,000	$5,900,000	$17,600,000
Coquitlam	$21,600,000	$6,900,000	$28,500,000
Surrey	$16,000,000	$1,100,000	$17,100,000
Township of Langley	$12,800,000	N/A	$12,800,000
Abbotsford	$16,800,000	$200,000	$17,000,000
Totals	**$78,900,000**	**$14,100,000**	**$93,000,000**

Based on the information collected during the benchmarking phase of the study, a number of likely future construction projects were evaluated to determine the estimated total additional cost due to the presence of the TMX. A summary of additional costs, by community, are included in Table 1-2 above. Table 1-3 below provides a summary of some of the likely future sources of these additional costs.

Table 1-3
Estimated Additional Cost for Future Construction Projects

Proposed Project	Estimated Total Additional Cost
Small Water Main in Urban Setting • perpendicular crossing of TMX • TMX does not require relocation	$41,000
Small Water Main in Urban Setting • perpendicular crossing of TMX • TMX must be raised/lowered due to water main alignment, for a length of 20 m	$ 371,000
Storm Trunk Main in Urban Setting • perpendicular crossing of TMX • TMX does not require relocation	$ 53,000
Storm Trunk Main in Urban Setting • perpendicular crossing of TMX • additional infrastructure required to modify storm trunk alignment (pump house, retention pond, etc.	$ 4,917,000
2 Lane Road Widening (to 4 lane) in Urban Setting • perpendicular crossing of TMX • TMX does not require relocation	$ 112,000
2 Lane Road Widening (to 4 lane) in Urban Setting • perpendicular crossing of TMX • TMX requires lowering	$ 706,000
2 Lane Road Widening (to 4 lane) in Urban Setting • TMX runs parallel to existing road and will be covered by road surface • TMX requires lowering and re-bedding for 1000 m of pipe	$ 4,349,000
Underpass/Overpass Construction in Urban Setting • perpendicular crossing of TMX • TMX requires lowering	$ 1,490,000

The results in Tables 1-1 through 1-3 demonstrate:

- The presence of the existing TransMountain Pipeline (TMP) results in $5.0M annually of additional costs to the five Lower Mainland municipalities to operate, maintain and replace infrastructure they already have in place:
  - $577K (including administration costs and contingencies) of this are additional costs for simple routine maintenance and repair work;
  - $4.4M of additional funds are spent annually replacing of rehabilitating municipal assets to KM permit standards.
- In the next 50 years, the subject Lower Mainland municipalities will spend an estimated $221M in additional costs when replacing their infrastructure at the end of its useful life as a result of the TMP
- The presence of the future TransMountain Expansion Pipeline (TMX) will result in $1.6M of additional annual costs to the five Lower Mainland municipalities to operate, maintain and replace existing infrastructure;
  - $350K (including Administration and contingencies) of this are additional costs for routine maintenance and repair work around the TMP;
  - $1.3M of additional funds will be needed to replace or rehabilitate aging municipal assets..
- In the next 50 years, the subject Lower Mainland municipalities will spend an estimated $61.4M in additional costs to replace their infrastructure at the end of its useful life as a result of the TMX.
- Costs to municipalities will increase as new infrastructure is constructed around the TMX.

The subject Lower Mainland municipalities will inevitably expand as population grows over the next 50 years. These municipalities will require new and higher capacity infrastructure to meet these needs. Municipalities are already considering projects that either move or avoid the existing TMP, and these costs will be significant. The municipalities do not have 50 year plans, and therefore we have estimated that each municipality will need to spend money to move or accommodate the proposed TMX into the future. These future cost impacts are derived using values in Table 1-3 and summarized by municipality in Table 1-2.

7 MITIGATION MEASURES

Some of the costs identified in Table 1-3 can be reduced by developing a plan that coordinates design criteria and reduces risk and impacts by working with each municipality.

We have identified a variety of impacts that the municipalities face with the presence of both the existing and proposed pipeline. We note some mitigation strategies that have been successfully used with other private utilities or in other communities that can assist in reducing the cost impacts to the subject Lower Mainland municipalities. Some of the more critical mitigation measures include:

- Installing casings across the TMX for existing utilities and identified future utilities
- Remove and replace existing parallel utilities outside of the minimum 5 m zone of influence
- Twin the pipeline where possible
- Increase the pipe wall thickness of the TMX pipeline through the municipalities
- Install the TMX as deep as possible in areas of soft/difficult soil conditions

- Install the TMX using trenchless technologies wherever possible
- Require regular settlement monitoring of the TMX in areas of soft/difficult soil conditions.
- Require KM to develop detailed crossing, operating and design procedures specific to each impacted municipality in conjunction with each municipality
- Include a municipal representative (for each municipality) during the detailed planning and design phases for the TMX
- In instances where the TMX crosses a road and the TMX is constructed to a standard to prevent settlement (ie. Poor soils or pilings), the road base should also be constructed in a manner to ensure that it and the pipe settle at the same rate.

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1 Introduction

The Trans Mountain Pipeline (TMP), owned and operated by Kinder Morgan (KM), carries petrochemicals from Alberta to the Pacific west coast. In 2013, KM applied to the National Energy Board (NEB) for approval to construct an expansion to the Trans Mountain Pipeline system.

The existing TMP was constructed in the early 1950's, and the communities along its route have grown and developed around it. The proposed expansion includes the installation of a 900 mm diameter pipeline, the Trans Mountain Expansion (TMX). The pipeline path will follow the existing pipeline for approximately 70% of its length however, in more urban areas, KM has generally proposed a new route for the expansion due to the urbanization around the TMP.

While KM has acknowledged that there will be a disruption to municipal infrastructure during construction of the proposed TMX pipeline, there has not yet been acknowledgement of the long term cost impacts to municipalities for operation, maintenance and construction of municipal infrastructure around the proposed expansion.

1.1 STUDY OBJECTIVE

In October 2014, the cities of Surrey, Burnaby, Coquitlam, Abbotsford and the Township of Langley retained Associated Engineering to complete an assessment of additional costs incurred by each municipality to operate, maintain and construct municipal infrastructure impacted by KM's TMP and TMX. The objective of the work was to:

1. Identify whether or not municipalities will incur additional costs to develop, maintain and construct their own municipal infrastructure as a direct and/or indirect result of the proposed TMX.
2. Quantify the present and estimated future additional costs that each subject municipality would incur as a result of the proposed pipeline operating within the vicinity of existing and future municipal infrastructure.
3. Suggest mitigation opportunities KM could undertake in respect of the proposed TMX to reduce future costs that would otherwise be incurred by the subject municipalities.

1.2 OVERALL METHODOLOGY

To assess the impact of the TMX project on the operation, maintenance and construction of municipal infrastructure, Associated Engineering chose to use activities related to the existing TMP as a historical benchmark. AE's methodology was essentially:

1. To identify if the municipalities were incurring additional costs due to operations, maintenance and construction of municipal infrastructure around the existing TMP.
2. To quantify any additional cost that was incurred as a result of the existing TMP.

3. To project the impact of the proposed TMX on the existing municipal infrastructure and to quantify the additional costs associated operating and maintaining existing municipal infrastructure within the pipeline's vicinity.
4. To project and quantify the additional costs associated with constructing new municipal infrastructure around both the existing and proposed pipelines.
5. To review potential mitigation practices which would reduce the cost impacts on the municipalities.

The following sections outline the steps AE took to follow the methodology described above. Figures detailing the proposed routing for the TMX can be found in Appendix A.

2 Background Information Review

To gain an understanding of the impact of the existing pipeline as well as the probable impact of the proposed pipeline, information and documentation was collected from various sources. This included the KM application to the NEB, as well as other KM documentation available online regarding policies, practices and regulations in place which may affect the operation and maintenance of a municipality's infrastructure near the TMP. More detailed information can be found in Appendix B of this report. A summary of the review findings is included below. It was noted during the review that KM's application to the NEB provides different standards of construction for the TMX than is required for new construction of facilities around the existing line. This is discussed later in the report.

2.1 PROPOSED TMX CONSTRUCTION DESIGN CRITERIA

The following points summarize the proposed construction of the TMX, as understood by AE:

- The proposed alignment is approximate; a 150 m wide corridor has been provided to allow for deviations in the centre line alignment;
- The TMX will have a minimum cover of 0.9 m in soil and 0.6 m in rock;
- Minimum clearances between TMX and other infrastructure will be maintained:
  - Where buried utilities are encountered in rural areas, a minimum vertical clearance of 300mm will be maintained;
  - Where buried utilities are encountered in an urban area, a minimum vertical clearance of 700mm along with a precast slab will be installed;
  - The horizontal clearance between the TMX and any other parallel pipeline or utility will not be less than 1.0 m
  - The TMX centerline will typically be offset from the existing TMP centerline by a minimum of 5 m, in areas where twinning will occur;
- A typical TMX right-of-way ("ROW") is 18.2 m in width.

2.2 EXISTING TMP MANAGEMENT

The following information was extracted from KM information packages outlining requirements to be met by a municipality or private owner for working around and/or crossing the existing TMP. AE has assumed, in this analysis, that the proposed TMX will be managed according to the same requirements.

- Permitting & Notification
  - KM requires a proximity permit for any work of a permanent nature occurring within a TMP ROW, and for any work crossing the TMP;
  - KM requires that any work within 30 m of the TMP (also known as the safety zone) be done pursuant to a KM ground disturbance permit;
  - KM sometimes also requires permits beyond the 30 m the safety zone;
- Pipeline Location and Working Distances

- A KM inspector must be on site for the duration of any work that is conducted within 7.5 metres of the TMP;
- The TMP must be exposed by hand or hydrovac for all activities within 5 metres of the pipeline;
- All excavation within 0.6 m of the TMP must be excavated using hydrovac or manually using a hand shovel.

- Crossing Design
  - New municipal infrastructure crossing the TMP or ROW should be as close to 90 degrees as possible;
  - Pre-loading and/or surcharge are not allowed within the TMP ROW, and must have KM approval prior to works adjacent to the ROW;
  - New parallel works within a road allowance must maintain a minimum 1.5 m horizontal separation from the edge of the TMP;
  - No new parallel works are permitted within the TMP ROW (excluding those within a road allowance, as above);
  - Underground utilities must cross underneath the pipeline unless conditions make it impractical
  - Crossing utilities must maintain a constant elevation across the TMP ROW
  - Minimum vertical cover between TMP and surface works:
    - 1.2 m for roadways
    - 1.0 m for non-vehicular paths
    - 1.0 m for ditches
  - Minimum clearances between TMP and infrastructure:
    - 0.3 m for utilities other than fibre-optics
    - 0.6 m for fibre-optic cables
    - 2.0 m for any piping installed using directional drilling
  - Structural and select fill must be KM approved
  - Hand compaction is required for portions of the backfilling process

3 Benchmarking Additional Costs

AE met with staff of each the subject municipalities in separate meetings. From these meetings and subsequent discussions, it was confirmed that the municipalities were, in fact, incurring additional costs in operating, maintaining and constructing municipal infrastructure, as a result of the existing TMP. AE then set out to quantify these additional costs.

3.1 MUNICIPAL IMPACTS

The information collected from each municipality is discussed in the following sections.

3.1.1 City of Burnaby

Burnaby is home to the Burnaby Terminal, which is the terminus of the existing mainline TMP. Currently, products are sent from the Burnaby Terminal to the Westridge Marine Terminal via a single 762 mm pipeline which travels through a now fully developed area. The current TMP mainline passes through a residential development, but only for a relatively short length in comparison to the pipeline to the Westridge Terminal. The following information was collected from the City of Burnaby regarding municipal infrastructure around the existing TMP:

- Prior to performing emergency utility repair work in the vicinity of the pipeline, a KM inspector is required on site, resulting in significant delays. Further delays can occur if the emergency occurs outside of normal business hours.
- Installation of a new water main across the TMP resulted in additional design and construction costs. The initial submission, approved by KM for construction, showed the water main being installed over top of the TMP. The design was completed and tendered as such. However, when the KM inspector came to site, the inspector required that the water main be installed below the TMP. Additional design and inspection time was required to update the design to address the change.
- In 2007, on Inlet Drive, a contractor punctured the existing KM oil pipeline with an excavator. While Kinder Morgan shared the resulting liability and costs with the contractor and engineering consultant, the City's citizens and staff are now well aware of the dangers and risks of having an oil pipeline within their community.

3.1.2 City of Coquitlam

In Coquitlam, the existing TMP crosses underneath the Fraser River approximately 1 km west of the new Port Mann bridge, and routes through a major industrial area to the south of Highway 1 before travelling north through commercial and residential areas towards the Burnaby Terminal. The following information was obtained from the City of Coquitlam:

- Installing sidewalk letdowns and signs and fixing potholes require permits from KM when performing the work inside the safety zone
- Utility services constitute a large portion of the works impacted by the TMP. A hydrovac is necessary to expose the pipeline whenever work is performed near the pipeline and must be conducted at the City's cost.
- During a water main break on Cottonwood Avenue, City staff was delayed more than two hours while waiting for a KM inspector to arrive on site. Unable to stop the flow of water completely, the City throttled flow to the area. The inspector completed a ground disturbance permit ("GDP") for the repair work. When the City crew returned to the site to complete restoration, an additional GDP was required for the work.

3.1.3 City of Surrey

The existing TMP was constructed in the mid-1950's through the northern half of Surrey. At that time, the pipeline was constructed along major roads and through industrial areas. Over time, industrial, commercial and urban development has intensified and now surrounds the TMP ROW. The TMP now traverses residential areas, where residential construction around the TMP is limited to removable structures and restricted use, according to KM documentation.

Through our investigations, AE identified the following information regarding working around the TMP:

- The City experiences significant cost increases when performing work within the 18 m pipeline ROW. Operating within the safety zone also creates significant challenges with respect to permitting and delays.
- Typical construction contracts for City works require standard insurance policies for $5M coverage. Because of the 2007 incident in Burnaby (mentioned above) involving the TMP, Lower Mainland municipalities have increased their insurance coverage. As a result, additional premiums in construction tenders rose to over $20,000 per project (O&M or capital improvement). This cost is inevitably transferred back to the City as a part of the construction contract.
- KM requires GDP's when fixing potholes in the vicinity of the pipeline. The City is regularly exposed to risk if the pothole cannot be repaired in a timely manner due to permitting delays.
- The TMP is built on piles in some areas with soft soils. Over time, roads in soft soils experience differential settlement, however, those crossing the TMP have settled unevenly due to the effect of the piles. This has resulted in the City needing to reconstruct the roads on a more frequent basis to reduce these impacts, as the resultant hump in the road is a public safety issue.
- It was estimated that additional administration and coordination required for TMP impacted projects accounts for approximately 1% of the capital costs for every project involving KM

Examples of past instances were also provided, citing capital construction projects impacted by the presence of the TMP:

- 156th Street Underpass of Highway 1

  - Construction of an underpass of 156th St beneath the TransCanada Highway required the existing TMP to be lowered, as the existing elevation was too high for the final elevation of the new roadway.
  - KM coordinated and carried out the relocation, charging the costs to the City. The cost for this work was $1,641,000.
  - An additional $550,000 in project costs came about with respect to relocating the TMP and other utilities because of resulting design changes to Highway 1.
  - KM staff took longer to complete work than initially scheduled, increasing the underpass contractor's fixed costs related to insurance, bonding, site office rental, site security and quality control. This came at an additional project delay cost of $250,000 which was directly incurred by the City.
- South Fraser Perimeter Road (SFPR)
  - During design discussions for the SFPR, the City was advised by an engineering consultant that the TMP crossing of the SFPR required an additional $1M in lightweight fill and associated design costs to avoid settlement on the pipe.
- King Road near 139th Street
  - The existing TMP crossing under King Road near 139th Street is a suspended-form timber piled support structure. The structure was constructed by the City when King Road was established to minimize pipe settlement, as there was an existing Metro Vancouver concrete siphon located below the TMP. In October 2011, significant settlement was observed of the TMP resulting from the failure of several support structure brackets. The City absorbed the costs of reinstating the existing support structure at a price of $391,000, This additional cost could have been avoided if KM designed the pipeline to accommodate a future road above it.

3.1.4 Township of Langley

The TMP was constructed in the 1950's north of Highway 1 in an SE-NW direction. At the time, the vast majority of the pipeline was located through rural areas. The Township of Langley has the fastest (by percentage) growing population in the region, with the western part now fully developed but the eastern part still consisting mostly of rural properties. Approximately 75% of the Township's properties are located within the Provincial Agricultural Land Reserve. The proposed TMX is proposed to run parallel along the existing TMP until it reaches the developed areas (±217A Street) where it heads north to the rail tracks after which it runs parallel to the rail tracks through the industrial area of Langley and in the City of Surrey.

As most of the development of Langley occurred after the pipeline was constructed, Langley has not had to replace ageing infrastructure yet. However, more recently, the Township has experienced a number of impacts and delays related to operations and maintenance activities such as tree planting, ditch cleaning, and road paving.

Specifically, on several occasions Kinder Morgan has caused delay and cost to the Township in relation to activities that lie beyond the 30m safety zone or that are not of a nature that require a permit from KM under the legislation:

- The Township was reported to the NEB by KM for undertaking surface milling and paving activities (less than 300mm depth) near the TMP due to concerns with vibrations;
- The Township was reported to the NEB by KM for not waiting for a permit to perform ditch cleaning, even though the proposed activity was approximately 180 metres away from the TMP;
- The Township was reported to the NEB by KM for undertaking tree removal which was damaged due to a car accident. After prepping the tree pit using shovels, the new tree was planted without using machine operated excavation.

As the Township continues to grow (expected to reach a population of 211,000 by 2041) it will require the necessary infrastructure to service the increase. The Township is concerned that the impacts and delays will continue to increase.

3.1.5 City of Abbotsford

Due to its eastern location, the City of Abbotsford has not developed as quickly as the more westerly Lower Mainland municipalities, and retains much of the of the rural land usage that was common to the entire pipeline route when the TMP was installed in the 1950's. Abbotsford is also home to the TMP Sumas Pump Station and Terminal, where a leak was discovered in 2005. A summary of the information collected from the City is provided below.

- The City performs maintenance on their ditches every year. To clean ditches, several crossings of the pipeline are organized ahead of time to make the permitting process less time consuming. Each permit does not take a large amount of time, but it is estimated that two hours of permitting is required for each session of ditch cleaning.
    - Where maintenance near the TMP is required, the ditches must be dug out by hand.
    - The City estimates that ditch cleaning costs around the TMP rises to approximately $20-25 per metre due to increased mobilization, communication and permitting activities. Normal ditch cleaning costs are typically $1.00 per metre.
- The City has constructed a road over the TMP. The City was required to allow TMP staff time to recoat and inspect their pipeline while it was uncovered, resulting in a significant delay in the City's schedule.
- A TMP break occurred in Abbotsford. The pipeline was installed in a peaty area and a property owner continued to add fill above the pipeline apparently with KM approval. Odour complaints were received by KM; however their further investigations did not detect any leaks. Eventually the City's fire department investigated and discovered the leak.

3.2 SOURCES OF ADDITIONAL COST

AE determined that the municipalities were being impacted by both direct and indirect costs:

- Direct costs involved a visible, measurable cost including those associated with permitting, design and construction. These costs were generally associated directly with a single maintenance incident or construction project.
- Indirect costs were generally associated with the overall operation of the municipalities with respect to municipal infrastructure in the presence of the TMP. These costs included risk mitigation, as well as additional administration and coordination costs.

3.2.1 Permits, Notifications & Location Services

The municipalities and KM both consider public safety as paramount. The municipalities recognize that all notification and location procedures are necessary, and that good communication between parties is crucial to minimizing risk. Municipalities spend significant time, effort and money in developing these communication protocols. While many of these costs are inherent with day to day operations, KM's permitting and notification requirements result in significant costs and delays. The costs below are specifically associated with the coordination of work and discussions with KM (including permits) prior to the commencement of onsite work. Information regarding permitting was taken from Kinder Morgan documentation, as discussed in Section 2.1.

Kinder Morgan permit requirements state that "*any person performing work that disturbs the ground surface in any way whatsoever within a Kinder Morgan Canada ("KMC") right of way or the 30 metre (100 feet) safety zone surrounding the Pipeline must call the applicable One Call centre listed below at least 3 business days prior to commencing the ground disturbance and meet the following procedures before proceeding with the ground disturbance.*"[1]

The background review revealed that KM is notified by BC OneCall of any intended ground disturbance within 100 m of any pipeline, at which point KM will verify the ground disturbance location and contract the responsible party to confirm site details and timing. Should KM determine that "*the ground disturbance may be within 30 metres (100 feet) of the Pipeline, within the right of way, or may, in some other way affect the Pipeline, the KMC inspector will ask the responsible party to arrange a site meeting.*" Before any ground work begins within 30 m of the pipeline, KM requires that a KM inspector must issue a ground disturbance permit; this permit must be kept on site at all times during the work.

KM also requires completion of a formal permitting process for all new works within or across a ROW and/or pipeline. This permit is referred to as a Pipeline Proximity Installation Permit and includes submission of a drawing package and formwork. This work is usually completed by a consultant, as such work is usually associated with an element requiring some level of design.

[1] *Ground Disturbance Pipeline Protection Requirements*. Kinder Morgan Canada Inc, May 2010. http://www.kindermorgan.com/pipelinesafety/Ground_Disturbance_Requirements.pdf. Accessed November 3, 2014.

Before construction can begin within the ROW itself or within the 30 m safety zone, KM requires that KM representatives must be on-site to identify the ROW. The municipality provides a representative during the ROW identification, and also for a KM meeting regarding construction in the area.

KM's *Ground Disturbance Pipeline Protection Requirements* document provides information regarding the required methods of construction for work around a pipeline. The requirements include the following:

- All work with power operated equipment within 5 m of the pipeline requires that the pipe be exposed by hand digging or hydrovac in at least one location, with additional locations at the discretion of KM.
- All ground disturbances with 0.6 m of either edge of the pipeline must be performed through hydrovac or hand digging.

In AE's analysis, the following assumptions were made with respect to additional cost from permitting and location services:

- A Ground Disturbance Permit (GDP) will be initiated and completed for all ground disturbances within the safety zone.
- A Pipeline Proximity Installation Permit (PPIP) will be initiated and completed mainly by a consultant, with assistance from the municipality, for all works crossing the pipeline.
- Work done by the municipality with respect to ROW identification and KM required site meetings will be done by a contractor.
- Municipalities will use hydrovac for all work within 0.6 m of the pipeline, and to locate the pipeline at one location when work is done within 5 m. Work to be done at standard hydrovac supplier rates.

KM rarely requires permits for work outside the 30 m safety zone, however, such occurrences have been reported. For this study, it has been assumed that permits will not be required outside the 30 m safety zone; however it is worth noting that there would be additional cost to the municipalities should KM require permits for work other than for which they already do.

3.2.2 Design Requirements

KM supplies municipalities and consultants with a document which provides design and construction guidelines for infrastructure near the KM pipeline.[2] KM specifies design criteria such as crossing angles, pipeline clearances, depth of cover and location of facilities and infrastructure. More detail can be found in the background review in Section 2, and in Appendix B.

In designing around the TMP, designers must not only meet the design criteria specified in the KM documentation, but must also assess the need for additional studies and geotechnical work. The following assumptions were made with respect to additional cost from design requirements:

[2] *Design and Construction Guidelines for the Installation of Facilities in proximity of Kinder Morgan Canada Operated Pipelines and Rights-of-Way.* Kinder Morgan Canada Inc, December 2011.
http://www.kindermorgan.com/pipelinesafety/DesignConstruction_guidlelines.pdf. Accessed November 3, 2014.

- Design work is to be completed by a consultant
- Design will meet KM's requirements as stated in the available literature
- There is no clarity in which design criteria takes precedence if there is a conflict.

For example, installing a gravity sewer underneath the pipeline will result in cost impacts in design due to planning, deeper excavations, new force mains, new pump stations and additional utilities to supply the facilities.

The design requirements for work around the TMP vary based on the type of infrastructure being designed. Assumptions and design criteria specific to different types of infrastructure can be found in Section 3.3.

3.2.3 Construction Requirements

KM requires that infrastructure meet certain criteria in order to be considered adequate for installation in or across a TMP ROW, and also provides criteria for the methods of construction of such works. Costs in this section are associated with the additional requirements for construction set out by KM.

KM provides contractors and/or municipalities with a list of equipment which may cross the ROW without the use of a temporary crossing structure, such as a bailey bridge. Any equipment not listed must be approved by KM before travelling across the pipeline or ROW.

Additional costs are borne by the municipalities because KM installs its pipe at shallow depths. This forces municipalities to install their utilities under the pipeline to meet KM vertical clearance requirements, requiring additional effort and cost for trenching, shoring, corrosion protection, site footprint, finishing and dewatering.

3.2.4 Delay

A significant cause of cost to the municipalities can be attributed to delays caused directly or indirectly by the TMP. Direct delay costs occur each time that the municipalities are required to meet KM's requirements regarding permitting and construction, or should KM not respond in a timely manner.

Municipalities have generally built the three day waiting period for a KM inspector into their project planning. However, in the case of an emergency, a KM inspector is generally not available immediately, and there can be a delay in completing the work. Although the municipalities are now absorbing the permitting costs as a part of their day to day activities, the cost for permitting remains an additional cost that can be attributed to the presence of the TMP or TMX.

KM has also demonstrated in the past that it uses all opportunities when its pipe is exposed to inspect and, if necessary, recoat the pipeline. This often causes a delay in the construction schedule, and can hold up an entire construction crew for a period of time. As well, extension of the estimated time line can affect

construction schedules and lead to requests for compensation. An example of this can be seen in the Surrey 156th Street Underpass project, described in Section 3.1 above.

The cost of delay is difficult to estimate, as the costs are a result of many factors which cannot be predicted. The length of a delay is dependent on factors such as the type of project, the availability of KM staff, the speed of KM contractors and decisions made by KM regarding the treatment of its pipeline.

3.2.5 Administration & Coordination

While the municipalities have accounted for scheduling KM requirements into their project plan, there is still an additional cost associated with the additional administrative work done internally. These costs can be attributed to the additional internal time taken to process the additional design and construction requirements, additional time coordinating staff around delays associated with the TMP and any additional document handling time including filing, phone calls, and project management.

Like delays, the additional cost of administration and coordination associated with the TMP is difficult to estimate, as the costs are a result of many different factors. As noted earlier, the City of Surrey estimated that additional coordination and administration accounts for an additional 1% on all construction projects around the TMP. Based on AE's experience, this estimate is reasonable.

3.2.6 Risk Mitigation

Additional risk is borne by both the municipalities and their contractors when completing work around the pipeline. The City of Surrey noted that it obtains additional insurance each year to cover municipal crews for work near the pipeline. It is reasonable to assume that contractors working for the municipalities would be expected to obtain the same insurance to protect themselves.

Additional risk occurs if the municipalities cannot address emergencies immediately, and must delay repair due to KM's requirement to wait for KM approval. In the case of a water main break, these delays may cause the municipality to leave residents without water. In the case of a pothole, the municipalities risk profile increases if a large potholes are not repaired immediately. The costs of these risks are difficult to quantify as they are circumstantial, however, there is some cost associated.

3.3 INFRASTRUCTURE IMPACTED BY THE TMP

In order to apply the sources of additional cost to the municipalities, the impacted municipal infrastructure was grouped into the following headings:

- Buried utilities
- Traffic infrastructure
- Overland drainage

Additional information is provided in the sections below.

3.3.1 Buried Utilities

For the purposes of this study, three “types” of buried utilities were considered: water, sanitary and storm. While it is understood that each type of buried infrastructure has a different purpose, the design and construction practices for each are very similar. Grouping these utilities as noted here avoided unnecessary over complication of the study. These utilities could then be categorized as follows:

- Small sized utilities – piping smaller than 300 mm in diameter
- Medium sized utilities – piping between 300 and 600 mm in diameter
- Transmission mains – piping larger than 600 m in diameter

For each size category, all utility pipe appurtenance costs were included with the pipe itself (ie. valves and manholes have been considered as part of the pipe and not evaluated separately).

In order to determine the costs associated with operations, maintenance, and construction of buried infrastructure, it was necessary to evaluate the activities for TMP impacts. The regular O&M activities evaluated for buried infrastructure included:

- Pipe repairs
- Manholes/valves/catchbasins/hydrants replaced or repaired
- Exercise valves
- Flushing
- Swabbing/jetting
- Chemical addition
- Pressure test
- Operate hydrants
- Unidirectional flushing

For design and construction for O&M, replacement and new capital works, the following assumptions were made:

- Designers need to account for the horizontal and vertical separation requirements, as well as consider additional appurtenances which may provide better access to the infrastructure.
- Buried utilities are installed at a greater depth due to the TMP clearance requirements, resulting in additional costs associated with a deeper trench.

3.3.2 Road Infrastructure

In urban centers, roadways take up a large portion of the ground surface area. Roads require operations and maintenance to operate as designed, and are a key piece of infrastructure in well-functioning cities. Provincially owned highways have been excluded from this analysis.

For the purposes of this study, five “types” of road infrastructure were considered. It was assumed that sidewalk and boulevard costs were included in all roads, with the exception of rural roads.

- Rural roads – unpaved roads of any width

- Ramps and connectors - these roads are paved, one lane, approximately 5 m wide
- Local Roads – these roads are paved, two lanes, approximately 10 m wide,
- Arterial Roads – these roads are paved, four lanes, approximately 20 m wide (includes a median and bike lanes)
- Major Boulevards or Roads – these roads are paved, 6+ lanes, minimum 30 m wide (e.g. United Boulevard in Coquitlam)

In order to determine the costs associated with operations and maintenance of road infrastructure, it was necessary to evaluate the activities for TMP impacts. Typical O&M activities may include:

- Inspection
- Sweeping
- Resurfacing
- Replacing signs
- Shoulder grading
- Grinding ruts
- Pothole repair
- Pavement marking
- Crack repair
- Guardrail repair
- Curb & gutter repair
- Sidewalk repair
- Snow removal
- De-icing
- Sand application
- Noise wall repair
- Mowing boulevards

For design and construction for O&M, replacement and new capital works, the following assumptions were made:

- Designers need to account for the horizontal and vertical separation requirements, as well as consider additional design elements, such as modified backfill or weight impacts, to meet KM's requirements for road infrastructure around the TMP.

- For all areas of road located over the TMP, it was assumed that road reconstruction would require re-bedding of the TMP, at the cost of the municipality, as is currently required.

3.3.3 Overland Drainage

For overland drainage, additional costs are expected in ditch cleaning activities, where KM notification and a ground disturbance permit is required before work can commence. Where total ditch reconstruction

projects are implemented, costs were limited to permitting and TMP location, as these tasks are responsible for the majority of the additional costs of the replacement.

3.4 OTHER FACTORS ASSOCIATED WITH ADDITIONAL COST

Other less typical but potential factors were also identified as additional costs, such as poor soils or geotechnical conditions, high traffic areas, high value property areas and additional instances of incurred additional cost. These are discussed further in the following sections.

3.4.1 TMP Relocation

In the past, there have been instances where a relocation of the existing TMP is required in order to construct new municipal infrastructure. In these cases, KM has allowed for the pipeline to be moved, however, doing so is at the cost of the municipality or construction project owner. KM will relocate its pipeline using a contractor of its choice, and will then require repayment of the entire cost from the municipality or project owner. In this case, the municipality or project owner has no control over the pipeline relocation construction, but is required to pay for the work. For example, Surrey's 156th Street Underpass (see Section 3.1.3).

3.4.2 TMP Pipeline Inspection and Recoating

Through discussions with the subject municipalities and review of KM's own documentation, it was discovered that KM will take any available instance to inspect and, if necessary, recoat its exposed pipelines. While KM generally bears the cost of these activities, the effects of the associated delay (schedule and cost) are the responsibility of the municipality.

3.4.3 Poor Soil Conditions

The primary conflict involving soils between the TMP and municipal systems in the Lower Mainland is with respect to transportation infrastructure. In areas where buried utilities are on piles but the road structure is not supported, differential settlement tends to occur. In situations where the TMP crosses roads or highways, unwanted "speed bumps" begin to take form, where the road rises or sinks, and the pipeline remains relatively stationary. These occurrences increase maintenance requirements along the roads, as well as decrease the life expectancy of the road to seven years instead of the 15 to 20 years expected in these areas. The City of Surrey, in particular, has had to replace lengths of road where these "bumps" occur every seven years. Road replacement also occurs where the pipeline runs underneath the road or sidewalk. Some consideration could be given to KM to build the full road base structure to the same standards expected for the pipeline, and offset some municipality costs.

3.4.4 Future Infrastructure

The existence of the TMP and TMX will impact future design and construction projects. While difficult to quantify, additional costs will be associated with adjusting designs to account for the existence of the TMP(s), and may appear as the requirement for a sewage lift station in a location which would not require one otherwise. Future planning for the municipalities was reviewed to estimate these costs to each of the municipalities.

3.5 SCENARIO COST DEVELOPMENT

Scenario cost development focused on the specific tasks and associated costs that arose when dealing with the operation, maintenance and construction of municipal infrastructure around the TMP. This included identification of the municipal tasks impacted by the presence of the TMP, an evaluation of those impacts, including resulting costs, and the costs required to mitigate these impacts. Information collected from the municipalities and good engineering judgement was combined in order to populate the estimated costs.

From the benchmarking process, the following scenario costs were created. Note that the actual costs for each “incident” are based on factors such as location (relative to pipeline) and type of infrastructure impacted (including size and material). Table 3-1 is a summary of additional cost ranges for each type of incident from detailed information found in Appendix C.

Table 3-1
Benchmarked Scenario Costs

Scenario	Unit	Estimated Additional Cost per Unit
Operations & Maintenance		
Buried Infrastructure		
Within Safety Zone	Per incident	$360
Within ROW	Per incident	$2,610 - $2,960
Crossing TMP	Per incident	$4,610 - $6,410
Road Infrastructure		
Within Safety Zone	Per incident	$360
Within ROW	Per incident	$2,010
Crossing TMP	Per incident	$2,010
Surface Drainage		
Within Safety Zone	Per incident	$360
Within ROW	Per incident	$2,010
Crossing TMP	Per incident	$2,010
Replacement		
Buried Infrastructure		
Within Safety Zone	Per replacement	$300
Within ROW	Per replacement	$25,710 - $26,510
Crossing TMP	Per replacement	$28,010 - $30,480
Road Infrastructure		
Within Safety Zone	Per replacement	$300
Within ROW	Per replacement	$24,150
Crossing TMP	Per replacement	$55,350 - $117,740

In addition to the costs above, municipalities spend more money replacing roads before the end of their typical useful life where poor soils exist. Road infrastructure is particularly vulnerable to settlement and requires replacement more often when installed over the TMP in an area of poor soils. Table 3-2 provides estimated costs for early replacement of road infrastructure.

Table 3-2
Additional Costs to Replace Road Infrastructure in Poor Soils

TGravel	1 Lane	2 Lane	4 lane	6 Lane
$115/m^2$	$207/m^2$	$173/m^2$	$161/m^2$	$150/m^2$

Municipalities are also subjected to both project-specific and annual costs associated with operating, maintaining and constructing capital projects around the TMP. These additional costs include:

- Project specific costs:
  - Installation of the TMP is estimated at $5,200 to $6,000 per metre
  - For relocation of the existing TMP, the cost will be two to three times the installation cost of the pipeline, ranging from $10,400 to $18,000 per metre, dependent on the details of the relocation
- The following annual costs:
  - Administration and coordination costs equal to 1% of yearly additional costs

Based on the information collected during the benchmarking phase of the study, a number of likely future construction projects were evaluated to determine the estimated total additional cost to the municipalities due to the presence of the TMX. Table 3-3 below provides a summary of some of the likely future costs.

Table 3-3
Estimated Additional Cost for Future Construction Projects
Urban Settings

Proposed Project	Projected Sources of Additional Cost	Additional Cost	Total
Small Water Main • perpendicular crossing of TMX • TMX does not require relocation	Permits, Notifications & Location Services	$ 4,500	$ 41,000
	Construction Requirements	$ 3,500	
	Design Requirements (15%)	$ 600	
	Risk Mitigation (Insurance)	$ 20,000	
	Administration & coordination	$ 300	
	Contingency (40%)	$ 11,500	
Small Water Main • perpendicular crossing of TMX • TMX must be raised/lowered due to water main alignment, for a length of 20 m	Permits, Notifications & Location Services	$ 4,500	$371,000
	Construction Requirements (TMX Rebedding)	$ 45,500	
	Design Requirements (15%)	$ 6,900	
	TMX Relocation (20 m length)	$ 185,500	
	Risk Mitigation (Insurance)	$ 20,000	
	Administration & coordination	$ 2,700	
	Contingency (40%)	$ 105,000	
Storm Trunk Main • perpendicular crossing of TMX • TMX does not require relocation	Permits, Notifications & Location Services	$ 4,500	$53,000
	Construction Requirements	$ 10,900	
	Design Requirements (15%)	$ 1,700	
	Risk Mitigation (Insurance)	$ 20,000	
	Administration & coordination	$ 400	
	Contingency (40%)	$ 14,900	
Storm Trunk Main • perpendicular crossing of TMX • raising/lowering of TMX does not meet requirements for clearance, unreasonable to assume TMX be relocated completely • additional infrastructure required to modify storm trunk alignment (pump house, pond, etc.)	Permits, Notifications & Location Services	$ 4,500	$4,917,000
	Construction Requirements	$ 10,900	
	Additional storm infrastructure required	$ 3,000,000	
	Design Requirements (15%)	$ 451,700	
	Risk Mitigation (Insurance)	$ 20,000	
	Administration & coordination	$ 34,900	
	Contingency (40%)	$ 1,394,900	

Proposed Project	Projected Sources of Additional Cost	Additional Cost	Total
2 Lane Road Widening (to 4 lane) • perpendicular crossing of TMX • TMX does not require relocation	Permits, Notifications & Location Services	$ 4,500	$ 112,000
	Construction Requirements (TMX Rebedding)	$ 42,000	
	Design Requirements (15%)	$ 6,300	
	Delay Costs	$ 6,600	
	Administration & Insurance	$ 20,800	
	Contingency (40%)	$ 31,800	
2 Lane Road Widening (to 4 lane) • perpendicular crossing of TMX • TMX requires lowering	Permits, Notifications & Location Services	$ 4,500	$ 706,000
	Construction Requirements (TMX Rebedding)	$ 85,200	
	Design Requirements (15%)	$ 12,800	
	Delay Costs	$ 6,600	
	TMX Relocation (40 m length)	$ 371,000	
	Administration & Insurance	$ 25,100	
	Contingency (40%)	$ 200,100	
2 Lane Road Widening (to 4 lane) • TMX runs parallel to existing road and will be covered by road surface • TMX requires lowering and rebedding for the length of the pipe (1000 m)	Permits, Notifications & Location Services	$ 4,500	$ 4,349,000
	Construction Requirements (TMX Rebedding)	$ 1,420,000	
	Design Requirements (15%)	$ 213,000	
	Delay Costs	$ 6,600	
	TMX Relocation (1000 m length)	$ 1,420,000	
	Administration & Insurance	$ 50,900	
	Contingency (40%)	$ 1,233,700	
Underpass/Overpass Construction • perpendicular crossing of TMX • TMX requires lowering	Permits, Notifications & Location Services	$ 4,500	$ 1,490,000
	Construction Requirements (TMX Rebedding)	$ 85,200	
	Design Requirements (15%)	$ 12,800	
	Delay Costs	$ 6,600	
	TMX Relocation (100 m length)	$ 927,500	
	Administration & Insurance	$ 30,600	
	Contingency (40%)	$ 422,700	

4 Analysis

The following analysis projects the overall additional cost per municipality related to the presence of the Trans Mountain pipelines using parameters defined in the earlier benchmarking process. This required further identification of impacted infrastructure using GIS in each municipality, then applying the benchmarked costs to each impacted component.

4.1 GIS MAPPING

As part of this study, each municipality provided detailed database inventories of their existing infrastructure. Following some compilation, the existing TMP and proposed TMX alignments were then added to the database. These alignments, along with the municipal infrastructure databases, were used to quantify infrastructure along the pipeline paths which currently is impacted by the TMP, and which would likely be impacted by the TMX.

4.1.1 Identification of Impacted Infrastructure

The following data processing procedure was used to process the information for all municipalities.

4.1.1.1 Buried Utilities

Existing and proposed pipeline alignments were extracted from Trans Mountain alignment PDF sheets obtained online through the Kinder Morgan application to the NEB. These alignments were then digitized manually and geo-referenced. Where TMX or TMP alignment was not available or yet to be defined, the information was then sourced from the municipality or through air photo interpretation. We understand that the TMX routing is not finalized. The results presented here are based on the pipeline route as proposed in October 2014.

Using the existing and proposed alignments, “zones of concern” files were created:

- Red – An 18m pipeline ROW - defined by KM (further divided into 5m and 9.1m to identify different permitting and excavation requirements)
- Yellow – The 30m Safety Zone - identified for permitting by KM
- Green - 100m Contact Zone - These would be used to calculate infrastructure occurrences within those distances from the proposed and existing pipelines.

Where the pipeline is to be twinned (ie. Abbotsford), AE expanded the “red zone” to equal 9.1 m on either side of each pipeline. Although KM has stated in its application that it plans to install the TMX within the same ROW where possible, and it does not plan to expand the ROW, many of KM’s requirements are related to the distance from the pipeline, rather than the defined ROW edge. For this reason, the “red zone” often was greater than 18.2 m along the twinned portions of the study.

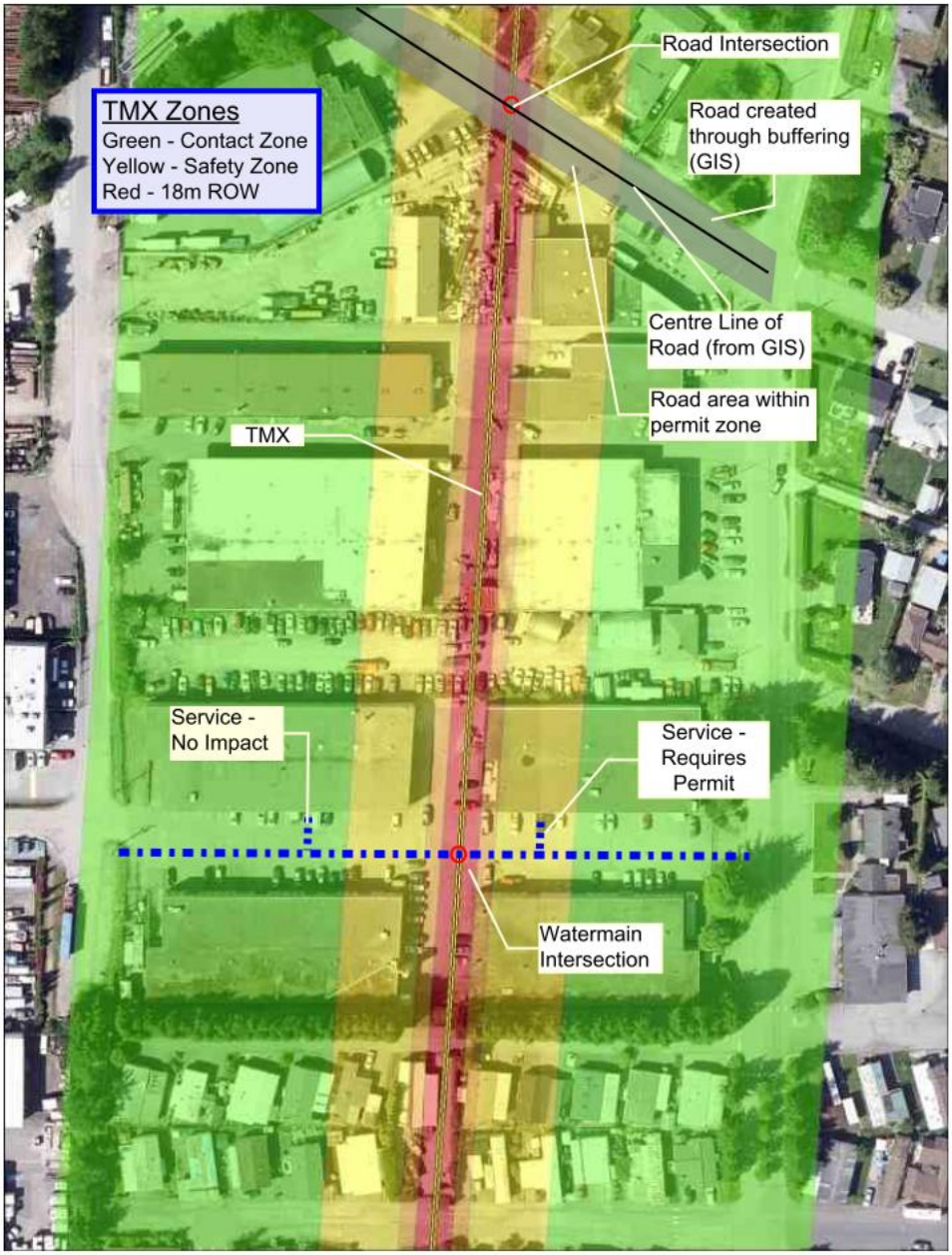


Figure 4-1 – Example of Impact Zones in GIS or Orthophotos

A “red zone” was also added to the entire length of the TMX route, even though the TMX route follows many existing infrastructure ROWs in the more urban areas, and it is unlikely that KM will own the ROW for these sections. The municipalities are aware that the red zone along the TMX route will likely be comprised of both KM ROWs and road/utility allowances owned by others, such as the municipalities themselves, but without a detailed assessment of legal ownership of the proposed pipeline route, it was difficult to determine which sections would require a KM ROW and which would be installed within existing road allowance.

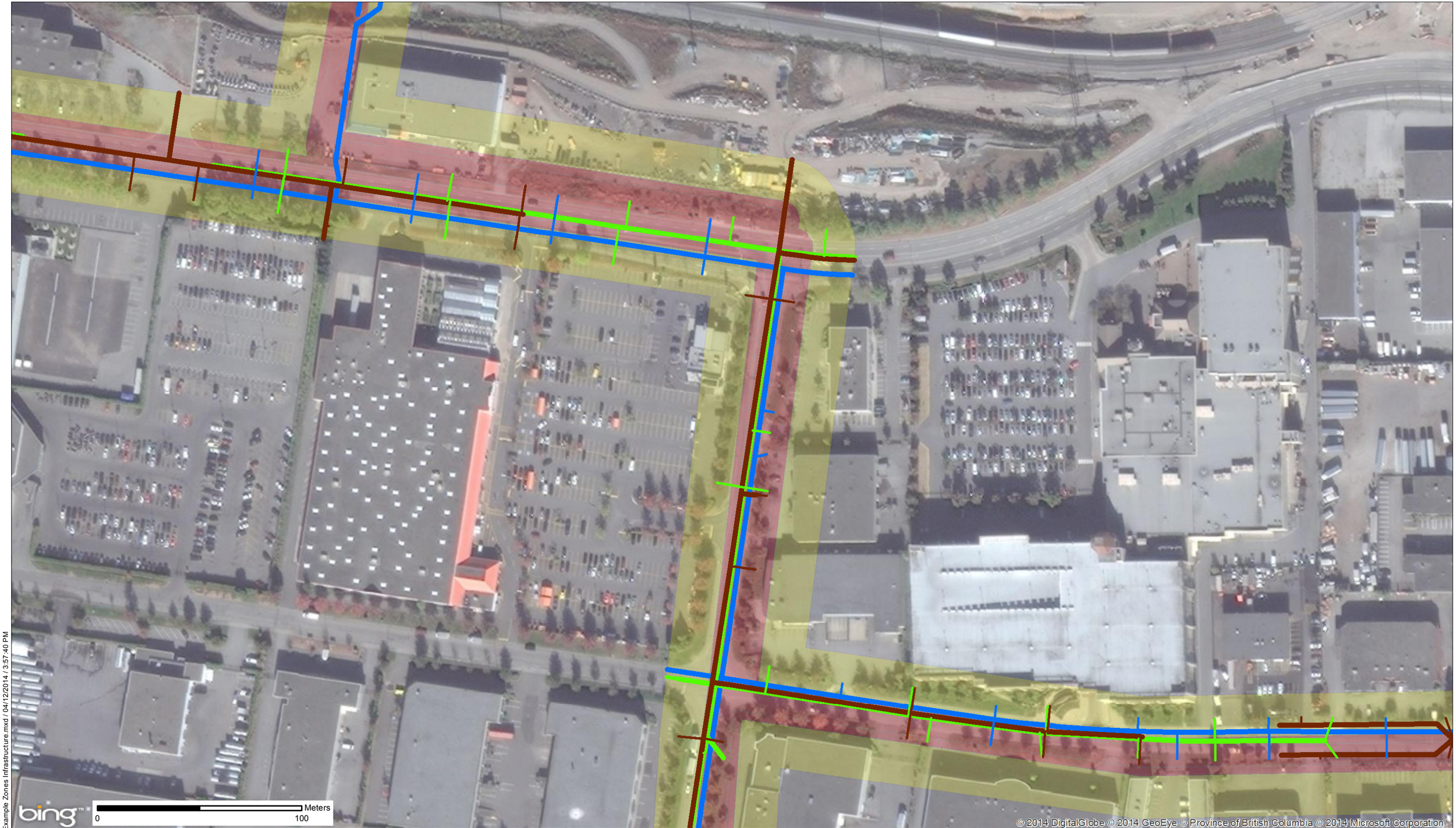
Once the base layers required for the analysis were created, they were intersected with the data provided by each municipality. Using ArcGIS Model Builder, a model was created to iterate through each dataset intersecting the municipal data and creating the line or points. This process created new spatial data files that represent the intersection of the lines and zones with each of the municipal layers. The corresponding results were then queried and exported to spreadsheets for analysis.

4.1.1.2 Roads

Roads were handled differently, as the TMP or TMX did not always cross roads, but were equally impacted because of their adjacency. The GIS road data supplied by the municipalities consisted only of a road centre line. All road width data was only included in the database, or assumed based on class of road, These road classifications and design parameters vary by municipality, or parts of a municipality. A procedure was therefore undertaken to determine the areal impact of the TMP/TMX permit zone, and effectively determine the additional cost impacts due to the presence of the existing or proposed pipeline:

- Intersections: A simple crossing of the centre lines. By totalling the number of crossings and multiplying by a typical unit construction cost per project or O&M unit cost per incident (similar to buried utilities above), the additional costs for road projects for each intersection in the community could be determined.
- Adjacent road and pipe: There are many instances where roads are impacted by the TMP. Additional costs to conduct O&M or replace a road were determined on a per square metre basis for different levels of KM’s permitting requirements. A conversion was required to create a road surface knowing the number of lanes in the road (See table 4.1). Both the road surface and the TMP permit zone surfaces were overlaid, resulting in areas of impact under each condition.

All data was then exported to a database by municipality. All information is available in Appendix D (Table Dx.1 for each municipality). Figures 4-2 and 4-3 provide examples of the road zones and buried utilities intersecting with the KM pipelines.



Example Zones Infrastructure.mxd / 04/12/2014 / 3:57:40 PM

Associated Engineering

Sanitary
Storm
Water

KMP Zones

18m
60m

PROJECT NO.: 2014-2798.000.000
DATE: Dec. 2014
DRAWN BY: DA

N

FIGURE 4-3: EXAMPLE OF SELECTED INFRASTRUCTURE WITHIN KMP ZONES

Municipal Consortium

Buried Utilities

Example Zones roads.mxd / 04/12/2014 / 4:01:18 PM

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Associated Engineering

Exisitng Pipeline Crossing

Proposed Pipeline Crossing

Modeled Road Surface

KMP Zones

18m

60m

PROJECT NO.: 2014-2798.000.000

DATE: Dec. 2014

DRAWN BY: DA

N

FIGURE 4-2: EXAMPLE OF ROADS WITHIN KMP ZONES

Municipal Consortium

Roads

**Table 4-1
Road Buffer Widths**

Number of Lanes	Road Line Buffer Width (metres on either side of line)	Represented Road Width (m)
1	2.5	5
2	5	10
3	7.5	15
4	10	20
5	12.5	25
6	15	30

Tables 4-2 and 4-3 below summarize the infrastructure for each municipality which is currently impacted by the TMP, and which will be impacted by the route of the proposed TMX. The information included in these tables was extracted using the GIS mapping and identification method described above. In some cases, information was not available within the database; this has been noted in the tables below.

Table 4-2
TMP Impacted Infrastructure by Municipality

Municipality	Buried Infrastructure		Road Infrastructure		Overland Drainage
	TMP Crossings	Length of Utilities in Safety Zone (m)	TMP Crossings	Area of Road Infrastructure in Safety Zone (m^2)	TMP Crossings
Burnaby	304	19,500	125	53,890	17
Coquitlam	887	22,669	125	45,022	7
Surrey	702	28,120	54	60,271	75
Township of Langley	195	7,650	74	47,384	61
Abbotsford	112	5,513	51	43,610	108
Totals	2200	85,452	429	250,177	268

Table 4-3
TMX Impacted Infrastructure by Municipality

Municipality	Buried Infrastructure		Road Infrastructure		Overland Drainage
	TMX Crossings	Length of Utilities in Safety Zone (m)	TMX Crossings	Area of Road Infrastructure in Safety Zone (m^2)	TMX Crossings
Burnaby	40	10,484	21	64,588	8
Coquitlam	149	12,562	14	38,094	9
Surrey	39	4,813	11	20,252	25
Township of Langley	37	4,674	21	17,577	39
Abbotsford	58	4,907	48	38,020	108
Totals	323	37,440	115	178,531	189

4.1.2 Poor Soils

Soils and geotechnical characterization are normally reserved for design discussions. However, certain soils properties impact the overall design of the TMX.

The municipalities have identified poor soils as an issue in many of their descriptions of infrastructure impacts in this study. “Poor” soils in these municipalities can more broadly defined as "peaty" soils; those with extreme clay conditions; or areas where landfills with non-homogeneous soils properties are prevalent. The concern for the municipalities is in the varying approaches to design criteria between the TMX and municipal infrastructure. The municipalities have taken the general approach that infrastructure is constructed within native conditions, whereas an oil transmission main is design for minimal flexibility and increased strength. These differences often show where a transmission mainline is constructed on piles or the strength is increased to resist movement, whereas municipal infrastructure is not. This leads to instances where roads and highways have “bumps” because the road has dropped in an area and the TMP has not. This has reduced the life expectancy of the municipal roads significantly.

The municipality understand that the costs of the TMP crossing for the South Fraser Perimeter Highway were impacted significantly with the need to use lightweight fill where peat soils were encountered. These costs were significantly higher than a typical installation.

Soil information for the study area was obtained by overlaying the TMX alignments onto Ministry of Environment (MOE) Soil Maps (2013) for the Greater Vancouver and Fraser Valley regions. The basic soil mapping unit used was the soil series, consisting of soils derived from a similar kind of parent material which have soil profiles, textures, and soil moisture characteristics that fall within a narrow, defined range. The descriptions for each soil series were provided in the database file linked to each soil mapping unit as well as accompanying soil reports (Luttmerding 1984).

To determine the occurrence and areal extent of organic deposits (“peaty” soils) in the study area, the soils database file was queried to determine soil mapping units that have been classified as organic according to the Canadian System of Soil Classification (Soil Classification Working Group 1998). Organic soils identified in the project area included:

- Typic Fibrisols (TY.F),
- Typic Mesisols (TY.M), and,
- Typic Humisols (TY. H).

In addition to this soil layer, a soil map layer was created for the old Coquitlam landfill on the proposed TMX alignment along United Boulevard. It is assumed that this area will have non-homogeneous geotechnical conditions similar to the peaty soils, and that Kinder Morgan will provide similar additional pipe stabilization (piles) as part of their installation.

Using the GIS soils layer and municipality-supplied infrastructure layers, values were collected for the amount of road infrastructure for each municipality impacted by the pipelines and located in an area of poor soil. Table 4-4 summarizes this information.

Table 4-4
Road Infrastructure Likely to be Impacted by Poor Soils

Municipality	Area of Road Infrastructure Located in Poor Soils and over TMP/TMX (m^2)
TMP Impacted	
Burnaby	N/A
Coquitlam	375
Surrey	592
Township of Langley	430
Abbotsford	241
TMX Impacted	
Burnaby	N/A
Coquitlam	2,677
Surrey	305
Township of Langley	305
Abbotsford	221

4.2 APPLICATION OF SCENARIO COSTS TO EXISTING INFRASTRUCTURE

A challenge in this study was establishing a time period over which to examine the impacts of the TMX. The life expectancy of the TMX will span beyond the normal planning horizon of all of the municipalities (typically 10 or 20 year plans). For this reason, the project team decided an annualized cost approach would be the most effective for determining operation, maintenance and replacement/construction costs. These annual costs could then be extrapolated easily to provide longer term costs beyond the municipalities' 10 or 20 year plans. The annualized costs are determined in the benchmarking exercises from actual annual costs from past work around the TMP, in addition to single "events" that have occurred.

Cost impacts were calculated using the unit costs produced during the benchmarking exercise, and applied to the GIS 'count' of each municipality's infrastructure. Operating and maintenance costs were based on information provided by the municipalities, and were calculated based on what percent of the utility would be subjected to an O&M activity on an annual basis. Replacement costs were calculated by assuming that all existing infrastructure would be replaced over its expected useful life. Once the cost for the replacement of the entire infrastructure system was calculated, it was manipulated to determine an equivalent annual cost.

Application of the scenario costs to the TMP route was done based on the same assumptions and regulations/requirements used to develop the costs, including documented requirements for horizontal and vertical clearances. A review of the KM application to the NEB for the TMX identified that KM plans to modify a number of its documented requirements for the TMX installation, mainly with respect to horizontal and vertical clearances between the TMX and existing facilities. Table 4-5 below identifies some of the differences between KM's requirements for other facility installation, and the TMX installation plan.

Table 4-5
Comparison of Facility Requirements for TMP and TMX

Facility Requirement	TMP (KM Crossing Requirements)	TMX (NEB Application)
Parallel Facilities	Minimum 1.5 m clearance between parallel facilities in road allowance	Minimum 1.0 m clearance between existing facilities and proposed TMX alignment
Clearance Between Adjacent Facilities	Adjacent facility must be installed a minimum of 0.3 m below the existing TMP	TMX to be installed with a minimum clearance of 0.3 m in rural areas and 0.7 m in urban areas, where practical
Facility Crossing Depth	Facility must be installed under TMP	Not directly specified
Installation of other facilities	No provision for additional facility protection provided	A precast slab is to be installed between the TMX and adjacent facility in some locations

Although the planned clearances differ between the TMP and TMX, AE did not modify the benchmarking costs to account for these changes. This choice was made based on the unclear and sometimes conflicting information regarding installation of the TMX around existing municipal facilities and infrastructure with regard to depth and installation of the slab, and the assumption that after installation of the TMX, facility/infrastructure owners would be required to abide by the same requirements as they currently are for the TMP. A detailed analysis of the crossing depth and clearance of each facility/infrastructure along the proposed route was outside of the scope of this report. AE believes that this assumption is reasonable for this study.

It is important to note that locations where the pipeline was twinned and those where the TMX route deviates from the existing TMP route were treated the same. In each case, both the TMP and TMX were counted as crossings, and the 30 m zone was extended out from each. We note that in locations where the existing route is proposed to be twinned, some of the impacts could be reduced because of the ability to combine permitting, locating, design and construction services. AE chose to complete the assessment this way so to not provide a "discount" for locations along the proposed TMX route where the TMP already exists.

Additional information regarding the calculation of the annualized costs can be found in the sections below.

4.2.1 Operations & Maintenance Costs

Operations and maintenance are conducted by municipal staff and is budgeted on an annual basis. For this analysis, we have identified occurrences where typical O&M operations are impacted by the TMP or TMX as "Incidents".

O&M costs were estimated for each municipality using the following information:

- Number of O&M incidents occurring for infrastructure within the area impacted by the KM pipeline
- Additional cost for each O&M incident that occurs, and at each "zone" of impact

While this information was provided by each municipality involved in this study, Surrey and Coquitlam were able to also provide a specific location tag in their database for over 15 years of data. The following factors were developed by dividing the number of annual O&M incidents along the TMP route over the total quantity of impacted utility and road infrastructure:

- 0.12% of buried infrastructure (by length) is impacted annually.
- 0.07% of road infrastructure (by area) is impacted annually.

These numbers were used to project the expected number of incidents for a year for each municipality in the benchmarking cost exercises in Tables Dx.2 through 5 for each of the municipalities.

For overland drainage, AE chose to base costs on information provided by the municipalities regarding their ditch cleaning schedule. Abbotsford and Langley currently clean their creeks and ditches on a six year cycle. A drainage course cleaning budget was then included for all municipalities assuming 1/6th of the ditches were maintained annually.

4.2.2 Replacement Costs

Additional cost for replacing each asset was calculated, and then divided by its useful (expected) life to estimate an approximate annual cost. It is understood that these costs may not be representative of the

actual costs of a municipality in a given year; instead they were meant to reflect the annualized average costs over an indefinite time period.

In each instance for asset replacement, assumptions were made as to the length of buried utility, or area of road infrastructure, to be replaced at a time. This was necessary in order to apply "per incident" costs such as permitting, location of the TMP/TMX and insurance.

- Buried utilities:
  - We have assumed that each buried utility asset will require replacement, on average, at least once during a 50 year period
  - Length of replacement is 100 m, regardless of utility type or size
- Roads
  - A typical road, including base and asphalt, will be replaced at least once every 40 years
  - Asphalt or other surface reconditioning will continue to occur every 10 years
  - A typical road, constructed in poor soil, will have a useful life of 15 years
  - A typical road, constructed in poor soil, crossing over a TMX or TMP on piles will require a total rebuild every seven years (to reduce the "hump" effect)
  - A length of replacement is 100 m, regardless of road type or width
  - Additional costs were attributed to replacement of road surface located directly above the TMP

4.2.3 Future Projects

Each municipality provided master planning and community planning documents for the period of time they had available. AE analyzed the documentation to determine which future projects may be impacted by the TMP and/or TMX, then used the scenario costs to attempt to estimate the cost impacts on the construction of those projects. These municipal plans do not project specific projects beyond 10 to 20 years, therefore, the municipalities provided some additional information where future projects or expected impacted areas can be anticipated over the next 40 years. We anticipate that some of the smaller impacts would be absorbed with the 40 percent contingency factor.

4.2.4 Other Costs

Once the annualized costs for each municipality were calculated, the following costs were added:

- 1% of annual additional costs to account for additional administration and coordination
- A 40% contingency factor has been applied to all estimated construction and O&M costs. Contingencies are based on a Class 5 estimate for project screening, where the expected accuracy range is as broad as -50% to 100% (ASTM 2516).

4.3 MUNICIPALITY SPECIFIC ANALYSIS

Information specific to the analysis for each municipality is included in the sections below. Results of the analysis have been included in Section 5. Spreadsheets including the details for each municipality can be found in Appendix D.

4.3.1 City of Burnaby

Similar to the existing TMP, the proposed TMX is intended to terminate in Burnaby. The mainline will end at the Burnaby Terminal, and two new 762 mm pipelines will be used to transfer products from that terminal to the Westridge Marine Terminal. This dual line system would be responsible for a large portion of the impact on Burnaby's infrastructure by the TMX.

The following points summarize the modifications to the approach used to assess the cost impacts of the TMX through Burnaby:

- It was assumed that all sanitary would be considered small buried infrastructure, and all storm would be considered medium buried infrastructure. No information was available from the GIS database regarding the size of the sanitary or storm infrastructure impacted by the TMX.
- The dual NPS 30 lines between Burnaby Terminal and Westridge Marine Terminal were assessed for cost impact in the same manner as the TMX. This was done to include these lines within the scope of this study.
- No soils information was available for the pipeline route.

It should be noted that pipelines will be installed directly below the road surface for a significant stretch (3.1 km) of Hastings Street. This could have a significant impact on this section of roadway, particularly if the area is subject to settlement. Soils information for this area was not available.

4.3.2 City of Coquitlam

The proposed TMX alignment avoids much of the residential areas in Coquitlam, and follows established municipal road allowances, including a significant portion of United Boulevard. A key area of concern in this area is related to the old landfill, where roads are already experiencing differential pavement settlement, likely caused by decomposition of the landfill materials. The new alignment would pass through these areas, prompting concerns of road settlement around the pipeline, and requiring the entire area to be reconstructed more often than it currently is. The City of Coquitlam has noted that road reconstruction may be required in the United Boulevard area within the next 20 years.

For Coquitlam, residential services have been included in the analysis and were analyzed using the costs for small buried utilities.

4.3.3 City of Surrey

The proposed TMX alignment enters Surrey to the east along Golden Ears Way. The alignment generally follows proposed Golden Ears Connector and extends through Surrey Bend Regional Park, eventually crossing the existing CN rail line and recently constructed South Fraser Perimeter Road. The alignment is then routed up an embankment near residences along the Fraser River before realigning with Highway 17 up to the Port Mann Bridge. The pipeline is routed from Surrey to Coquitlam under the Fraser River, on the east side of the Port Mann Bridge.

The City of Surrey has expressed concerns with several aspects of the current proposed alignment. The proposed alignment shows minimal effort to minimize environmental, social or economic impacts to the community. The alignment particularly avoids BCMOT right of ways and CN Rail, and instead is routed through the ecologically sensitive Surrey Bend Regional Park. On many occasions, the City has avoided installing any infrastructure within this environmentally sensitive area.

The City also has also expressed concerns with the proposed alignment through areas of poor soil quality (particularly peaty soils). The City's infrastructure is currently designed to specific standards in these areas. Any additional exposure of this infrastructure to external pipelines through these areas significantly increases the costs of repair or replacement of the infrastructure.

4.3.4 Township of Langley

In Langley, the TMX route is primarily through agricultural lands. The most developed area of the TMX route is in the vicinity of the Golden Ears Bridge, where there is significant road and utility infrastructure owned and operated by the Township.

There are pockets of poor soil along the route of the TMX through Langley. No detailed project plans are anticipated in these areas at this time.

4.3.5 City of Abbotsford

For much of the proposed alignment through Abbotsford, the TMX will be twinned with the existing pipeline and will follow the existing ROW. The only variance where a separation between the two pipes is to occur is around Matsqui Indian Reserve lands. This is for a very short distance and is beyond City of Abbotsford jurisdiction. The alignment generally avoids urban areas, and uses the extensive ROW options and routing over agricultural lands.

Two Abbotsford locations were identified for future underground utilities work along the TMP and TMX routes:

- At the Gladwin Road location, a 1200 mm diameter water main will be installed
- 200-300 metres west of Gladwin Road a 1050 trunk sanitary sewer is proposed

With respect to road crossings, the municipality stated that the number of new crossings in the future would likely be limited to the proposed development area across from the tank farm on Sumas Mountain Road, and that only two or three new crossings are likely in the foreseeable future. The City will likely design future development to limit the crossings of the TMP and TMX, in order to reduce the pipelines' impact.

4.4 ADDITIONAL COSTS

During the completion of this study, several concepts were identified in which additional cost, not quantified by the scenarios, could be accrued by the municipalities. These areas are identified further below.

4.4.1 OneCall Zone

For this analysis, it was assumed that KM will not require permits for work outside the safety zone. Currently, KM is notified by OneCall every time a OneCall ticket is created for the area within 100 m of the TMP. Should KM require permits for work outside 30 m but within 100 m of the pipeline, as some of the subject municipalities have experienced, costs can be expected to increase significantly.

4.4.2 Concrete Slab

Concerns have been identified that the concrete slab proposed by KM for the TMX would result in additional costs for the installation and access of buried infrastructure crossing the pipeline. The KM application to the NEB is unclear as to the detailed locations of the concrete slabs, and provides drawings for both with and without slabs. Other presented options included the possibility of concrete walls around the TMX. Where the TMX is installed below existing utilities, this may work for the TMX, however will add complexity and consequently additional costs to municipalities in instances where the TMX must be relocated for construction of a new project. Where the TMX is installed above existing utilities, this may a barrier to accessing existing utilities, again resulting in additional costs to the municipalities.

4.4.3 Repair of Facilities

AE's research of other KM crossing agreements outside of the Lower Mainlined found that if the municipality's infrastructure requires replacement or repair due to KM accessing its pipelines, that the cost of repair of the infrastructure will lay 50% with the municipality and 50% with KM. This agreement results in the municipalities being partially responsible for repairing roads and buried utilities which are damaged through no fault of their own. We are not certain at this stage if KM would be looking for similar outcomes in future crossing agreements with the subject municipalities.

4.4.4 Currently Unidentified Construction Projects

It is evident that the proposed TMX alignments avoid existing infrastructure and residential areas, where possible, to decrease their install costs and reduce the initial impact on the municipal infrastructure. However, as the municipalities grow and develop around the TMX, additional costs will be incurred due to the operation, maintenance and construction of infrastructure which cannot be predicted at this level of study. This long term impact is proven by the increased existence and maintenance of municipal utilities around the TMP in Surrey and in the Township of Langley.

AE used the benchmarked costs to develop estimated additional costs for some potential projects which would be impacted by the TMX. These are intended to be conceptual level only, as details such as location, soil type and design will all impact the actual costs.

4.4.5 Unknown Soil Conditions

At the time of writing this report, AE was not aware of the specific pipeline design criteria for the TMX or the extent of work that KM performs to enhance geotechnical/soil conditions for its pipelines. The analysis here used known soils information that is obtained to an accuracy expected from 1:20,000 mapping. On a job by job basis, we know that peaty conditions are prevalent throughout the Lower Mainland, and particularly in the Coquitlam, Surrey and Langley areas. We assume this is part of the contingency applied at this time.

5 Results

Based on the information gathered as part of this study, and the analysis completed as described in Section 4, the following conclusions have been reached:

The results in Tables 5-1 below demonstrate:

- The presence of the existing TransMountain Pipeline (TMP) results in $5.0M annually of additional costs to the five Lower Mainland municipalities to operate, maintain and replace infrastructure they already have in place:
  - $577K (including administration costs and contingencies) of this are additional costs for simple routine maintenance and repair work;
  - $4.4M of additional funds are spent annually replacing of rehabilitating municipal assets to KM permit standards.
- In the next 50 years, the subject Lower Mainland municipalities will spend an estimated $221M in additional costs when replacing their infrastructure at the end of its useful life as a result of the TMP.
- The presence of the future TransMountain Expansion Pipeline (TMX) will result in $1.6M annually of additional costs to the five Lower Mainland municipalities to operate, maintain and replace existing infrastructure;
  - $350K (including Administration and contingencies) of this are additional costs for routine maintenance and repair work around the TMP;
  - $1.3M of additional funds will be needed to replace or rehabilitate aging municipal assets.
- In the next 50 years, the subject Lower Mainland municipalities will spend an estimated $61.4M in additional costs to replace their infrastructure at the end of its useful life as a result of the TMX.
- Costs to municipalities will increase as new infrastructure is constructed around the TMX.

The subject Lower Mainland municipalities will inevitably expand as population grows over the next 50 years. These municipalities will require new and higher capacity infrastructure to meet these needs. Municipalities are already considering projects that either move or avoid the existing TMP, and these costs will be significant. The municipalities do not have 50 year plans, and therefore we have estimated that each municipality will need to spend money to move or accommodate the proposed TMX into the future.

Table 5-1
Summary of Annualized Additional Costs for Municipal Infrastructure

Municipality	O&M [1]	Replacement[1]	Subtotal
TMP			
Burnaby	$143,600	$1,078,000	$1,221,600
Coquitlam	$107,300	$1,505,000	$1,612,300
Surrey	$154,200	$1,015,000	$1,169,200
Township of Langley	$84,500	$356,000	$440,500
Abbotsford	$87,300	$472,000	$559,300
Totals	$576,900	$4,426,000	$5,002,900
TMX			
Burnaby	$77,900	$156,000	$233,900
Coquitlam	$116,200	$316,000	$432,200
Surrey	$59,800	$260,000	$319,800
Township of Langley	$52,000	$204,000	$256,000
Abbotsford	$44,500	$292,000	$336,500
Totals	$350,400	$1,228,000	$1,578,400

Notes:
1. Includes Administration and Coordination, Risk Mitigation and Contingency (industry practice is 40% for Class 5 projects)
2. All values in 2014 $.

The subject Lower Mainland municipalities will inevitably expand as population grows over the next 50 years. These municipalities will require new and higher capacity infrastructure to meet these needs. Municipalities are already considering projects that either move or avoid the existing TMP, and these costs will be significant. The municipalities do not have 50 year plans, and therefore we have estimated that each municipality will need to spend money to move or accommodate the proposed TMX into the future. These future cost impacts are derived using values from the benchmarking exercise and summarized by municipality in Table 5-2.

Table 5-2
Summary of Additional Costs to be incurred by the Municipalities over 50 years

Municipality	TMX	Future Expected Projects	Totals
Burnaby	$11,700,000	$5,900,000	$17,600,000
Coquitlam	$21,600,000	$6,900,000	$28,500,000
Surrey	$16,000,000	$1,100,000	$17,100,000
Township of Langley	$12,800,000	N/A	$12,800,000
Abbotsford	$16,800,000	$200,000	$17,000,000
Totals	**$78,900,000**	**$14,100,000**	**$93,000,000**

Spreadsheets detailing the results for each municipality can be found in Appendix E. Additional detail on the costs above for each municipality can be found in the sections below.

5.1 CITY OF BURNABY

The table below summarizes the additional costs associated with the operation, maintenance and replacement of existing infrastructure in the City of Burnaby, due to the impact of the TMP and TMX.

Table 5-3
City of Burnaby Annualized Additional Costs

Item	TMP	TMX
O&M Costs[1]	$106,600	$54,900
Administration & Coordination	$2,000	$1,000
Contingency (40%)	$41,000	$22,000
Subtotal O&M	**$143,600**	**$77,900**
Replacement Costs[2]	$764,000	$110,000
Administration & Coordination	$8,000	$2,000
Contingency (40%)	$306,000	$44,000
Subtotal Replacement	**$1,078,000**	**$156,000**
Total Annual Additional Costs	**$1,221,600**	**$233,900**
Combined		**$1,456,000**

Notes
1. From Table E1.1 and E1.3
2. From Table E1.2 and E1.4

In addition, the TMX, is to be routed through the Lake City Business Centre, where the City of Burnaby has a long term development plan (the Lake City Area Plan). This area, over the next 30 to 50 years, will include a significant population increase, resulting in upgrades to current infrastructure including the extension of the Lougheed-Gaglardi intersection. The estimated overall cost of this project is in the range of $27M to $32M. The presence of the TMX will result in significant additional costs for this project.

Table 5-4 is an estimate of the additional costs to the City of Burnaby in the long term:

Table 5-4
Burnaby Long Term Development Projects

Proposed Project	Projected Sources of Additional Cost	Estimated Additional Cost	Total
Lake City Area Plan Eastlake Road Reconstruction and widening (1000 m)	Permits, Notifications & Location Services	$ 4,500	$ 4,349,000
	Construction Requirements (TMX Rebedding)	$ 1,420,000	
	Design Requirements (15%)	$ 213,000	
	Delay Costs	$ 6,600	
	TMX Relocation (1000 m length)	$ 1,420,000	
	Administration & Insurance	$ 50,900	
	Contingency (40%)	$ 1,233,700	
Gaglardi/Highway 6 Interchange • perpendicular crossing of TMX • TMX requires lowering	Permits, Notifications & Location Services	$ 4,500	$ 1,490,000
	Construction Requirements (TMX Rebedding)	$ 85,200	
	Design Requirements (15%)	$ 12,800	
	Delay Costs	$ 6,600	
	TMX Relocation (100 m length)	$ 927,500	
	Administration & Insurance	$ 30,600	
	Contingency (40%)	$ 422,700	
Long Term Additional Costs (Rounded)			**$5,900,000**

5.2 CITY OF COQUITLAM

The table below summarizes the additional costs associated with the operation, maintenance and replacement of existing infrastructure in the City of Coquitlam, due to the impact of the TMP and TMX.

Table 5-5
City of Coquitlam Annualized Additional Costs

Item	TMP	TMX
O&M Costs[1]	$75,300	$82,200
Administration & Coordination	$1,000	$1,000
Contingency (40%)	$31,000	$33,000
Subtotal O&M	**$107,300**	**$116,200**
Replacement Costs[2]	$1,067,000	$223,000
Administration & Coordination	$11,000	$3,000
Contingency (40%)	$427,000	$90,000
Subtotal Replacement	**$1,505,000**	**$316,000**
Total Annual Additional Costs	**$1,612,300**	**$432,200**
Combined		**$2,045,000**

Notes
1. From Table E2.1 and E2.3
2. From Table E2.2 and E2.4

Since the TMP route currently passes through a developed residential area with many municipal services, the impact of the TMP is quite high. The lower annual costs associated with infrastructure affected by the proposed TMX is due mainly to the reduction of the number of buried utilities and road crossings within the proposed route.

The City of Coquitlam has plans to reconstruct roads in the United Boulevard area in the next 20 years, resulting in significant additional construction annual maintenance costs. The table below summarizes the additional project costs expected with the projected reconstruction of United Boulevard and adjacent roads impacted by the pipelines.

Table 5-6
Coquitlam Proposed Projects

Proposed Project	Projected Sources of Additional Cost	Estimated Additional Cost	Total
Widening of United Boulevard • widening to occur along 1600m length	Permits, Notifications & Location Services	$4,500	$6,932,000
	Construction Requirements (TMX Rebedding)	$2,272,000	
	Design Requirements (15%)	$340,800	
	Delay Costs	$6,600	
	TMX Relocation (1600 m length)	$2,272,000	
	Administration & Insurance	$69,200	
	Contingency (40%)	$1,966,400	
Long Term Additional Costs (Rounded)			**$6,900,000**

5.3 CITY OF SURREY

The table below summarizes the additional costs associated with the operation, maintenance and replacement of existing infrastructure in the City of Surrey, due to the impact of the TMP and TMX.

Table 5-7
City of Surrey Annualized Additional Costs

Item	TMP	TMX
O&M Costs[1]	$108,200	$41,800
Administration & Coordination	$2,000	$1,000
Contingency (40%)	$44,000	$17,000
Subtotal O&M	**$154,200**	**$59,800**
Replacement Costs[2]	$719,000	$184,000
Administration & Coordination	$8,000	$2,000
Contingency (40%)	$288,000	$74,000
Subtotal Replacement	**$1,015,000**	**$260,000**
Total Annual Additional Costs	**$1,169,200**	**$319,800**
Combined		**$1,489,000**

Notes
1. From Table E3.1 and E3.3
2. From Table E3.2 and E3.4

Since the TMP route currently passes through a developed residential area in Surrey, the impact of the TMP is quite high. The lower annual costs associated with infrastructure affected by the TMX is due mainly to the reduction of the number of buried utilities and road crossings along the proposed route.

The City provided the following projects that are expected to occur beyond the existing infrastructure plan:

- South Fraser Perimeter Road
  - 750mm storm / culvert crossing perpendicular to TMX
  - 1800mm storm / culvert crossing perpendicular to TMX
- 179th St./Daly Road Intersection - Road widening from 2 lane to 4 lane in perpendicular to TMX.
- Big Bend Sanitary Pump Station Replacement.
  - The proposed TMX route passes directly behind the proposed station location. Construction of the station is expected to require sheet piling, dewatering and additional geotechnical work to ensure the TMX is protected. This may involve vibration monitoring, slower sheet piling installation and contractor risk. The station is expected to cost around $2M, and the City of Surrey is expecting $250,000 in additional costs.

Table 5-8
Surrey Proposed Projects

Proposed Project	Projected Sources of Additional Cost	Estimated Additional Cost	Total
Storm Trunk Main (x2) • perpendicular crossing of TMX • TMX does not require relocation	Permits, Notifications & Location Services	$4,500	2 x $53,000
	Construction Requirements	$10,900	
	Design Requirements (15%)	$1,700	
	Administration & Insurance	$20,400	
	Contingency (40%)	$14,900	
2 Lane Road Widening (to 4 lane) in Urban Setting • perpendicular crossing of TMX • TMX requires lowering	Permits, Notifications & Location Services	$ 4,500	$706,000
	Construction Requirements (TMX Rebedding)	$ 85,200	
	Design Requirements (15%)	$12,800	
	Delay Costs	$ 6,600	
	TMX Relocation (40 m length)	$ 371,000	
	Administration & Insurance	$ 25,100	
	Contingency (40%)	$ 200,100	
Big Bend Sanitary Pump Station			$250,000
Long Term Additional Costs (Rounded)			**$1,100,000**

5.4 TOWNSHIP OF LANGLEY

The table below summarizes the additional costs associated with the operation, maintenance and replacement of existing infrastructure in the Township of Langley due to the impact of the TMP and TMX.

Table 5-9
Township of Langley Annualized Additional Costs

Item	TMP	TMX
O&M Costs[1]	$59,500	$36,000
Administration & Coordination	$1,000	$1,000
Contingency (40%)	$24,000	$15,000
Subtotal	**$84,500**	**$52,000**
Replacement Costs[2]	$252,000	$144,000
Administration & Coordination	$3,000	$2,000
Contingency (40%)	$101,000	$58,000
Subtotal	**$356,000**	**$204,000**
Total Annual Additional Costs	**$440,500**	**$256,000**
Combined		**$697,000**

Notes
1. From Table E4.1 and E4.3
2. From Table E4.2 and E4.4

Due to the plan to twin a portion of the existing pipeline route, the impacts of the TMP and TMX along this portion were quite similar. As previously noted, the annual costs in areas of twinning will tend to be significantly less than the estimates as work can be combined around both pipelines. However, AE did not want to discount the cost to the municipalities due to the TMP already being in place, therefore both lines were addressed separately. The decreased cost impact of the TMX can be attributed to the less developed area associated with the pipeline alignment.

5.5 CITY OF ABBOTSFORD

The table below summarizes the additional costs associated with the operation, maintenance and replacement of existing infrastructure in the City of Abbotsford, due to the impact of the TMP and TMX.

Table 5-10
City of Abbotsford Annualized Additional Costs

Item	TMP	TMX
O&M Costs[1]	$61,300	$30,500
Administration & Coordination	$1,000	$1,000
Contingency (40%)	$25,000	$13,000
Subtotal	**$87,300**	**$44,500**
Replacement Costs[2]	$334,000	$206,000
Administration & Coordination	$4,000	$3,000
Contingency (40%)	$134,000	$83,000
Subtotal	**$472,000**	**$292,000**
Total Annual Additional Costs	**$559,300**	**$336,500**
Combined		**$896,000**

Notes
1. From Table E5.1 and E5.3
2. From Table E5.2 and E5.4

The table below includes the projected additional costs associated with the proposed municipal projects which may be affected by the presence of the TMP and TMX.

**Table 5-11
Abbotsford Proposed Projects**

Proposed Project	Projected Sources of Additional Cost	Estimated Additional Cost	Total
BURIED UTILITY PROJECTS			
1200 mm diameter water main installation • main will cross both TMP and TMX	Permits, Notifications & Location Services	$4,500	$41,000
	Construction Requirements	$3,500	
	Design Requirements (15%)	$600	
	Administration & coordination	$20,300	
	Contingency (40%)	$11,500	
1050 mm diameter trunk sanitary sewer • main will cross both TMP and TMX	Permits, Notifications & Location Services	$4,500	$41,000
	Construction Requirements	$3,500	
	Design Requirements (15%)	$600	
	Administration & Insurance	$20,300	
	Contingency (40%)	$11,500	
TRANSPORTATION PROJECTS			
2 Lane Road Widening • TMX does not require relocation	Permits, Notifications & Location Services	$4,500	$112,000
	Construction Requirements (TMX Rebedding)	$42,000	
	Design Requirements (15%)	$6,300	
	Delay Costs	$6,600	
	Administration & Insurance	$20,800	
	Contingency (40%)	$31,800	
Long Term Additional Costs (Rounded)			**$200,000**

Notes

1. These projects all assume no relocation of the TMP or TMX
2. Transportation projects assume that KM will require re-bedding of the pipelines for road construction

6 Mitigation Measures

In AE's opinion, there is no question the presence of the TMP, and subsequently the TMX is and will be, the source of additional costs for the municipalities when operating and replacing existing infrastructure and when constructing new infrastructure.

While detailed design considerations for constructing the TMX to reduce the impact on the municipalities is outside the scope of this report, AE provides the suggestions in the following sections to assist in mitigating these costs.

6.1 PIPELINE CONSTRUCTION

The following mitigation measures involve adjustments to the TMX alignment and/or construction details:

- Include a municipal representative (for each community) in the decision making process for the conceptual alignment and design of the TMX. The municipalities should be given input into the final route and construction methods, and should have an experienced advisor working with KM to determine the design which will be most beneficial to both parties. This representative should have some level of authority regarding the following:
  - The ability to review and provide feedback on changes which will impact municipal infrastructure
  - The ability to provide locations of particular concern and require KM to address the concerns through design modifications such as depth of cover
  - The ability to provide input into areas where trenchless technologies can possibly be used to install the TMX and reduce the impacts on the existing and future municipal infrastructure
- In areas where open trench installation is used for the TMX, install minimum 20 m length casings across the TMX for existing utilities to reduce the future impacts of accessing those utilities and provided an additional level of protection
- Identify location of future buried utilities and install casings under the TMX. This reduces the excavation around the TMX
- Install the TMX at a minimum of 5 m from existing parallel utilities, or relocate the utility to the minimum 5 m distance, in consultation with the municipality and where feasible
- Twin the pipeline where possible to reduce the overall impact on municipalities. This may require relocation of the TMP to the proposed TMX location. This would result in a smaller overall footprint for the KM pipelines, reducing the impact to the municipalities.
- Increase the thickness of the TMX pipeline walls as much as feasible to extend the service life of the TMX and reduce the risk of failure
- Locate the pipeline in areas without soft/difficult soil conditions wherever possible
- In areas where soft/difficult soil conditions are a factor, install the TMX as deeply as possible to reduce the impact on the infrastructure above and reduce the risk of differential settlement of other infrastructure affecting the TMX.

- In instances where the TMX crosses a road and the TMX is constructed to a standard to prevent settlement (ie. Poor soils or pilings), the road base should also be constructed in a manner to ensure that it and the pipe settle at the same rate.
- Install the TMX using trenchless technologies wherever possible. This will reduce the number of interactions with existing infrastructure which occur during construction.
- Install the TMX deep enough to be able to remove some of the requirements for permitting and locating for regular operations and maintenance activities.

6.2 ONGOING OPERATIONS

The following mitigation measures involve altering the way KM and the municipalities interact when it comes to the TMP and TMX:

- Require regular settlement monitoring of the TMX in areas of soft/difficult soil conditions and require KM to complete modifications to the TMX if the settlement rate is different than that for adjacent utilities.
- Require KM to accept responsibility for all infrastructure rehabilitation which occurs due to KM requiring access to their pipeline, and due to any failure of KM facilities. Currently the municipalities and KM are to split the cost of rehabilitation which can result in significant additional cost if the assets to be rehabilitated are of high value and/or high importance to the municipality's day to day functions.
- Reduce the number of permits required for day to day work.
- Enforce a delay penalty for work completed by Kinder Morgan which runs over schedule and affects the schedule of major construction projects.
- Require KM to develop detailed crossing, operating and design procedures specific to each impacted municipality, which can be evaluated as part of the design process.

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8 Certification Page

This report presents our findings regarding the Surrey, Coquitlam, Abbotsford, Burnaby & Township of Langley Cost Impacts of the TransMountain Expansion on Lower Mainland Municipalities.

Respectfully submitted,

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